Arrays Detectors

Fabrics that “See”: Photosensitive Fiber Constructs

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Textile fabric has provided essential protection from the environment for millennia—but it hasn't had much to offer in terms of optical functionality. Now, in a recent paper, we demonstrated that lightweight, flexible, photosensitive polymeric fibers woven into arrays can "see," potentially allowing for optical functionality in fabrics.1

The fibers, produced by a thermal drawing procedure, have a photosensitive core (an amorphous semiconductor) surrounded by a transparent polymer and in contact with four metal electrodes that extend the full length of the fiber, as shown in part (a) of the figure.2 The fibers will produce an electrical signal that is proportional to the line integral of the intensity of an incident optical field. Thus, a 2D array constructed of these fibers can reconstruct the amplitude of an arbitrary incident intensity distribution from rotated versions of the distribution using the Radon transform (b).1,3

Further, such an array is essentially transparent, and one may stack cascaded arrays to extend the optical functionalities. An example is shown in the figure, part (c), where two planar arrays separated by a distance d detect the position and direction of an optical beam. The flexibility of the fibers also allows us to construct novel array topologies such as that of a closed sphere that detects the path of a beam of light over the full 4\pi steradians of the ambient environment.1

Finally, two planar arrays that detect the intensity distributions in two planes can reconstruct both the amplitude and the phase of an incident wave front using the phase retrieval algorithm.1,4 We demonstrate the feasibility of this approach in a lensless imaging experiment, where we propagate the reconstructed complex field distribution backwards to estimate the illuminated object (d).

We have also recently demonstrated 2D arrays constructed of thermally sensitive fibers.5 Combining photosensitive and thermally sensitive fibers in a fabric will lead to clothing that sees and also senses the environment.4

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References